

## VALPROATE SODIUM - valproate sodium injection

Bedford Laboratories

### Rx ONLY

#### BOX WARNING

##### HEPATOTOXICITY

HEPATIC FAILURE RESULTING IN FATALITIES HAS OCCURRED IN PATIENTS RECEIVING VALPROIC ACID AND ITS DERIVATIVES. EXPERIENCE HAS INDICATED THAT CHILDREN UNDER THE AGE OF TWO YEARS ARE AT A CONSIDERABLY INCREASED RISK OF DEVELOPING FATAL HEPATOTOXICITY, ESPECIALLY THOSE ON MULTIPLE ANTICONVULSANTS, THOSE WITH CONGENITAL METABOLIC DISORDERS, THOSE WITH SEVERE SEIZURE DISORDERS ACCOMPANIED BY MENTAL RETARDATION, AND THOSE WITH ORGANIC BRAIN DISEASE. WHEN VALPROATE IS USED IN THIS PATIENT GROUP, IT SHOULD BE USED WITH EXTREME CAUTION AND AS A SOLE AGENT. THE BENEFITS OF THERAPY SHOULD BE WEIGHED AGAINST THE RISKS. ABOVE THIS AGE GROUP, EXPERIENCE IN EPILEPSY HAS INDICATED THAT THE INCIDENCE OF FATAL HEPATOTOXICITY DECREASES CONSIDERABLY IN PROGRESSIVELY OLDER PATIENT GROUPS. THESE INCIDENTS USUALLY HAVE OCCURRED DURING THE FIRST SIX MONTHS OF TREATMENT. SERIOUS OR FATAL HEPATOTOXICITY MAY BE PRECEDED BY NON-SPECIFIC SYMPTOMS SUCH AS MALAISE, WEAKNESS, LETHARGY, FACIAL EDEMA, ANOREXIA, AND VOMITING. IN PATIENTS WITH EPILEPSY, A LOSS OF SEIZURE CONTROL MAY ALSO OCCUR. PATIENTS SHOULD BE MONITORED CLOSELY FOR APPEARANCE OF THESE SYMPTOMS. LIVER FUNCTION TESTS SHOULD BE PERFORMED PRIOR TO THERAPY AND AT FREQUENT INTERVALS THEREAFTER, ESPECIALLY DURING THE FIRST SIX MONTHS.

##### TERATOGENICITY

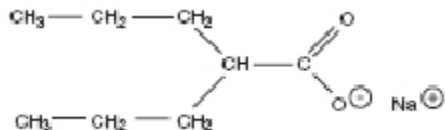
VALPROATE CAN PRODUCE TERATOGENIC EFFECTS SUCH AS NEURAL TUBE DEFECTS (E.G., SPINA BIFIDA). ACCORDINGLY, THE USE OF VALPROATE PRODUCTS IN WOMEN OF CHILDBEARING POTENTIAL REQUIRES THAT THE BENEFITS OF ITS USE BE WEIGHED AGAINST THE RISK OF INJURY TO THE FETUS. THIS IS ESPECIALLY IMPORTANT WHEN THE TREATMENT OF A SPONTANEOUSLY REVERSIBLE CONDITION NOT ORDINARILY ASSOCIATED WITH PERMANENT INJURY OR RISK OF DEATH (E.G., MIGRAINE) IS CONTEMPLATED. SEE WARNINGS, Information for patients.

##### PANCREATITIS

CASES OF LIFE-THREATENING PANCREATITIS HAVE BEEN REPORTED IN BOTH CHILDREN AND ADULTS RECEIVING VALPROATE. SOME OF THE CASES HAVE BEEN DESCRIBED AS HEMORRHAGIC WITH A RAPID PROGRESSION FROM INITIAL SYMPTOMS TO DEATH. CASES HAVE BEEN REPORTED SHORTLY AFTER INITIAL USE AS WELL AS AFTER SEVERAL YEARS OF USE. PATIENTS AND GUARDIANS SHOULD BE WARNED THAT ABDOMINAL PAIN, NAUSEA, VOMITING, AND/OR ANOREXIA CAN BE SYMPTOMS OF PANCREATITIS THAT REQUIRE PROMPT MEDICAL EVALUATION. IF PANCREATITIS IS DIAGNOSED, VALPROATE SHOULD ORDINARILY BE DISCONTINUED. ALTERNATIVE TREATMENT FOR THE UNDERLYING MEDICAL CONDITION SHOULD BE INITIATED AS CLINICALLY INDICATED. (See WARNINGS and PRECAUTIONS.

#### DESCRIPTION

Valproate sodium is the sodium salt of valproic acid designated as propylvaleric acid. Valproate sodium is formed in-situ with valproic acid (propylvaleric acid) and sodium hydroxide. Valproate sodium has the following structure:



Molecular Formula: C<sub>8</sub>H<sub>16</sub>O<sub>2</sub>Na

Valproate sodium has a molecular weight of 166.2. It occurs as an essentially white and odorless, crystalline, deliquescent powder. Valproate Sodium Injection is available in 5 mL single-dose vials for intravenous injection. Each mL contains valproate sodium equivalent to 100 mg valproic acid, edetate disodium 0.40 mg, and water for injection to volume. The pH is adjusted to 7.6 with sodium hydroxide and/or hydrochloric acid.

The solution is clear and colorless.

#### CLINICAL PHARMACOLOGY

Valproate sodium injection exists as the valproate ion in the blood. The mechanisms by which valproate exerts its therapeutic effects have not been established. It has been suggested that its activity in epilepsy is related to increased brain concentrations of gamma-aminobutyric acid (GABA).

## Pharmacokinetics

### Bioavailability

Equivalent doses of intravenous (IV) valproate and oral valproate products are expected to result in equivalent  $C_{\max}$ ,  $C_{\min}$ , and total systemic exposure to the valproate ion when the IV valproate is administered as a 60 minute infusion. However, the rate of valproate ion absorption may vary with the formulation used. These differences should be of minor clinical importance under the steady state conditions achieved in chronic use in the treatment of epilepsy.

Administration of divalproex sodium tablets and IV valproate (given as a one hour infusion), 250 mg every 6 hours for 4 days to 18 healthy male volunteers resulted in equivalent AUC,  $C_{\max}$ ,  $C_{\min}$  at steady state, as well as after the first dose. The  $T_{\max}$  after valproate sodium injection occurs at the end of the one hour infusion, while the  $T_{\max}$  after oral dosing with divalproex sodium occurs at approximately 4 hours. Because the kinetics of unbound valproate are linear, bioequivalence between valproate sodium injection and divalproex sodium up to the maximum recommended dose of 60 mg/kg/day can be assumed. The AUC and  $C_{\max}$  resulting from administration of IV valproate 500 mg as a single one hour infusion and a single 500 mg dose of divalproex sodium syrup to 17 healthy male volunteers were also equivalent.

Patients maintained on valproic acid doses of 750 mg to 4250 mg daily (given in divided doses every 6 hours) as oral divalproex sodium alone (n=24) or with another stabilized antiepileptic drug [carbamazepine (n=15), phenytoin (n=11), or phenobarbital (n=1)], showed comparable plasma levels for valproic acid when switching from oral divalproex sodium to IV valproate (1-hour infusion).

Eleven healthy volunteers were given single infusions of 1000 mg IV valproate over 5, 10, 30, and 60 minutes in a 4-period crossover study. Total valproate concentrations were measured; unbound concentrations were not measured. After the 5 minute infusions (mean rate of 2.8 mg/kg/min), mean  $C_{\max}$  was  $145 \pm 32$  mcg/mL, while after the 60 minute infusions, mean  $C_{\max}$  was  $115 \pm 8$  mcg/mL. Ninety to 120 minutes after infusion initiation, total valproate concentrations were similar for all 4 rates of infusion. Because protein binding is nonlinear at higher total valproate concentrations, the corresponding increase in unbound  $C_{\max}$  at faster infusion rates will be greater.

### Distribution

#### Protein Binding

The plasma protein binding of valproate is concentration dependent and the free fraction increases from approximately 10% at 40 mcg/mL to 18.5% at 130 mcg/mL. Protein binding of valproate is reduced in the elderly, in patients with chronic hepatic diseases, in patients with renal impairment, and in the presence of other drugs (e.g., aspirin). Conversely, valproate may displace certain protein-bound drugs (e.g., phenytoin, carbamazepine, warfarin, and tolbutamide). (See **PRECAUTIONS, Drug interactions** for more detailed information on the pharmacokinetic interactions of valproate with other drugs.)

#### CNS Distribution

Valproate concentrations in cerebrospinal fluid (CSF) approximate unbound concentrations in plasma (about 10% of total concentration).

#### Metabolism

Valproate is metabolized almost entirely by the liver. In adult patients on monotherapy, 30 to 50% of an administered dose appears in urine as a glucuronide conjugate. Mitochondrial  $\beta$ -oxidation is the other major metabolic pathway, typically accounting for over 40% of the dose. Usually, less than 15 to 20% of the dose is eliminated by other oxidative mechanisms. Less than 3% of an administered dose is excreted unchanged in urine.

The relationship between dose and total valproate concentration is nonlinear; concentration does not increase proportionally with the dose, but rather, increases to a lesser extent due to saturable plasma protein binding. The kinetics of unbound drug are linear.

#### Elimination

Mean plasma clearance and volume of distribution for total valproate are 0.56 L/hr/1.73 m<sup>2</sup> and 11 L/1.73 m<sup>2</sup>, respectively. Mean terminal half-life for valproate monotherapy after an intravenous infusion of 1000 mg was  $16 \pm 3.0$  hours.

The estimates cited apply primarily to patients who are not taking drugs that affect hepatic metabolizing enzyme systems. For example, patients taking enzyme-inducing antiepileptic drugs (carbamazepine, phenytoin, and phenobarbital) will clear valproate more rapidly. Because of these changes in valproate clearance, monitoring of antiepileptic concentrations should be intensified whenever concomitant antiepileptics are introduced or withdrawn.

## Special Populations

### Effect of Age

**Neonates** — Children within the first two months of life have a markedly decreased ability to eliminate valproate compared to older children and adults. This is a result of reduced clearance (perhaps due to delay in development of glucuronosyltransferase and other enzyme systems involved in valproate elimination) as well as increased volume of distribution (in part due to decreased plasma protein binding). For example, in one study, the half-life in children under 10 days ranged from 10 to 67 hours compared to a range of 7 to 13 hours in children greater than 2 months.

**Children** — Pediatric patients (i.e., between 3 months and 10 years) have 50% higher clearances expressed on weight (i.e., mL/min/kg) than do adults. Over the age of 10 years, children have pharmacokinetic parameters that approximate those of adults.

**Elderly** — The capacity of elderly patients (age range: 68 to 89 years) to eliminate valproate has been shown to be reduced compared to younger adults (age range: 22 to 26). Intrinsic clearance is reduced by 39%; the free fraction is increased by 44%. Accordingly, the initial dosage should be reduced in the elderly. (See **DOSAGE AND ADMINISTRATION**).

### Effect of Gender

There are no differences in the body surface area adjusted unbound clearance between males and females ( $4.8 \pm 0.17$  and  $4.7 \pm 0.07$  L/hr per  $1.73 \text{ m}^2$ , respectively).

### Effect of Race

The effects of race on the kinetics of valproate have not been studied.

### Effect of Disease

**Liver Disease** — (See **BOX WARNING, CONTRAINDICATIONS, and WARNINGS**). Liver disease impairs the capacity to eliminate valproate. In one study, the clearance of free valproate was decreased by 50% in 7 patients with cirrhosis and by 16% in 4 patients with acute hepatitis, compared with 6 healthy subjects. In that study, the half-life of valproate was increased from 12 to 18 hours. Liver disease is also associated with decreased albumin concentrations and larger unbound fractions (2 to 2.6 fold increase) of valproate. Accordingly, monitoring of total concentrations may be misleading since free concentrations may be substantially elevated in patients with hepatic disease whereas total concentrations may appear to be normal.

**Renal Disease** — A slight reduction (27%) in the unbound clearance of valproate has been reported in patients with renal failure (creatinine clearance  $<10$  mL/minute); however, hemodialysis typically reduces valproate concentrations by about 20%. Therefore, no dosage adjustment appears to be necessary in patients with renal failure. Protein binding in these patients is substantially reduced; thus, monitoring total concentrations may be misleading.

## Plasma Levels and Clinical Effect

The relationship between plasma concentration and clinical response is not well documented. One contributing factor is the nonlinear, concentration dependent protein binding of valproate which affects the clearance of the drug. Thus, monitoring of total serum valproate cannot provide a reliable index of the bioactive valproate species.

For example, because the plasma protein binding of valproate is concentration dependent, the free fraction increases from approximately 10% at 40 mcg/mL to 18.5% at 130 mcg/mL. Higher than expected free fractions occur in the elderly, in hyperlipidemic patients, and in patients with hepatic and renal diseases.

### Epilepsy

The therapeutic range in epilepsy is commonly considered to be 50 to 100 mcg/mL of total valproate, although some patients may be controlled with lower or higher plasma concentrations.

Equivalent doses of valproate sodium injection and divalproex sodium yield equivalent plasma levels of the valproate ion (see **CLINICAL PHARMACOLOGY, Pharmacokinetics**).

## CLINICAL STUDIES

The studies described in the following section were conducted with oral divalproex sodium products.

### Epilepsy

The efficacy of divalproex sodium in reducing the incidence of complex partial seizures (CPS) that occur in isolation or in association with other seizure types was established in two controlled trials.

In one, multiclinic, placebo controlled study employing an add-on design (adjunctive therapy), 144 patients who continued to suffer eight or more CPS per 8 weeks during an 8 week period of monotherapy with doses of either carbamazepine or phenytoin sufficient to assure plasma concentrations within the "therapeutic range" were randomized to receive, in addition to their original antiepilepsy drug

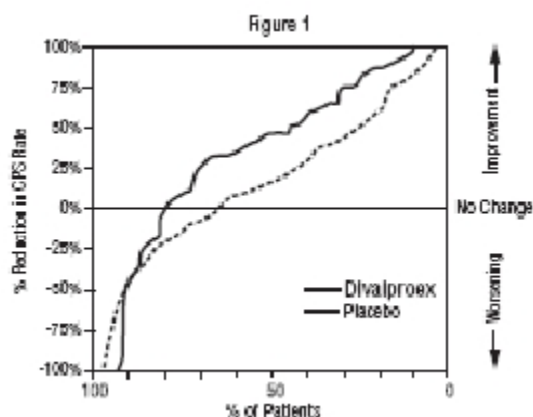
(AED), either divalproex sodium or placebo. Randomized patients were to be followed for a total of 16 weeks. The following table presents the findings.

Adjunctive Therapy Study - Median Incidence of CPS per 8 Weeks

Add-on Treatment	Number of Patients	Baseline Incidence	Experimental Incidence
Divalproex sodium	75	16.0	8.9*
Placebo	69	14.5	11.5

\*Reduction from baseline statistically significantly greater for divalproex sodium than placebo at  $p < 0.05$  level.

Figure 1 presents the proportion of patients (X axis) whose percentage reduction from baseline in complex partial seizure rates was at least as great as that indicated on the Y axis in the adjunctive therapy study. A positive percent reduction indicates an improvement (i.e., a decrease in seizure frequency), while a negative percent reduction indicates worsening. Thus, in a display of this type, the curve for an effective treatment is shifted to the left of the curve for placebo. This figure shows that the proportion of patients achieving any particular level of improvement was consistently higher for divalproex sodium than for placebo. For example, 45% of patients treated with divalproex sodium had a  $\geq 50\%$  reduction in complex partial seizure rate compared to 23% of patients treated with placebo.



The second study assessed the capacity of divalproex sodium to reduce the incidence of CPS when administered as the sole AED. The study compared the incidence of CPS among patients randomized to either a high or low dose treatment arm. Patients qualified for entry into the randomized comparison phase of this study only if 1) they continued to experience 2 or more CPS per 4 weeks during an 8 to 12 week long period of monotherapy with adequate doses of an AED (i.e., phenytoin, carbamazepine, phenobarbital, or primidone) and 2) they made a successful transition over a two week interval to divalproex sodium. Patients entering the randomized phase were then brought to their assigned target dose, gradually tapered off their concomitant AED and followed for an interval as long as 22 weeks. Less than 50% of the patients randomized, however, completed the study. In patients converted to divalproex sodium monotherapy, the mean total valproate concentrations during monotherapy were 71 and 123 mcg/mL in the low dose and high dose groups, respectively.

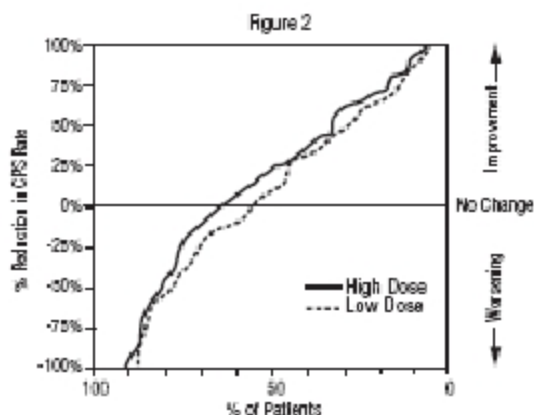
The following table presents the findings for all patients randomized who had at least one post-randomization assessment.

Monotherapy Study - Median Incidence of CPS per 8 Weeks

Treatment	Number of Patients	Baseline Incidence	Randomized Phase Incidence
High dose divalproex sodium	131	13.2	10.7*
Low dose divalproex sodium	134	14.2	13.8

\*Reduction from baseline statistically significantly greater for high dose than low dose at  $p < 0.05$  level.

Figure 2 presents the proportion of patients (X axis) whose percentage reduction from baseline in complex partial seizure rates was at least as great as that indicated on the Y axis in the monotherapy study. A positive percent reduction indicates an improvement (i.e., a decrease in seizure frequency), while a negative percent reduction indicates worsening. Thus, in a display of this type, the curve for a more effective treatment is shifted to the left of the curve for a less effective treatment. This figure shows that the proportion of patients achieving any particular level of reduction was consistently higher for high dose divalproex sodium than for low dose divalproex sodium. For example, when switching from carbamazepine, phenytoin, phenobarbital or primidone monotherapy to high dose divalproex sodium monotherapy, 63% of patients experienced no change or a reduction in complex partial seizure rates compared to 54% of patients receiving low dose divalproex sodium.



## INDICATIONS AND USAGE

Valproate sodium injection is indicated as an intravenous alternative in patients for whom oral administration of valproate products is temporarily not feasible in the following conditions:

Valproate sodium injection is indicated as monotherapy and adjunctive therapy in the treatment of patients with complex partial seizures that occur either in isolation or in association with other types of seizures. Valproate sodium injection is also indicated for use as sole and adjunctive therapy in the treatment of patients with simple and complex absence seizures, and adjunctively in patients with multiple seizure types that include absence seizures.

Simple absence is defined as very brief clouding of the sensorium or loss of consciousness accompanied by certain generalized epileptic discharges without other detectable clinical signs. Complex absence is the term used when other signs are also present. SEE **WARNINGS** FOR STATEMENT REGARDING FATAL HEPATIC DYSFUNCTION.

## CONTRAINDICATIONS

VALPROATE SODIUM INJECTION SHOULD NOT BE ADMINISTERED TO PATIENTS WITH HEPATIC DISEASE OR SIGNIFICANT HEPATIC DYSFUNCTION.

Valproate sodium injection is contraindicated in patients with known hypersensitivity to the drug.

Valproate sodium injection is contraindicated in patients with known urea cycle disorders (see **WARNINGS**).

## WARNINGS

### Hepatotoxicity

Hepatic failure resulting in fatalities has occurred in patients receiving valproic acid. These incidents usually have occurred during the first six months of treatment. Serious or fatal hepatotoxicity may be preceded by non-specific symptoms such as malaise, weakness, lethargy, facial edema, anorexia, and vomiting. In patients with epilepsy, a loss of seizure control may also occur. Patients should be monitored closely for appearance of these symptoms. Liver function tests should be performed prior to therapy and at frequent intervals thereafter, especially during the first six months of valproate therapy. However, physicians should not rely totally on serum biochemistry since these tests may not be abnormal in all instances, but should also consider the results of careful interim medical history and physical examination.

Caution should be observed when administering valproate products to patients with a prior history of hepatic disease.

Patients on multiple anticonvulsants, children, those with congenital metabolic disorders, those with severe seizure disorders accompanied by mental retardation, and those with organic brain disease may be at particular risk. Experience has indicated that children under the age of two years are at a considerably increased risk of developing fatal hepatotoxicity, especially those with the aforementioned conditions. When valproate sodium injection is used in this patient group, it should be used with extreme caution and as a sole agent. The benefits of therapy should be weighed against the risks. Use of valproate sodium injection has not been studied in children below the age of 2 years. Above this age group, experience with valproate products in epilepsy has indicated that the incidence of fatal hepatotoxicity decreases considerably in progressively older patient groups. The drug should be discontinued immediately in the presence of significant hepatic dysfunction, suspected or apparent. In some cases, hepatic dysfunction has progressed in spite of discontinuation of drug.

### Pancreatitis

Cases of life-threatening pancreatitis have been reported in both children and adults receiving valproate. Some of the cases have been described as hemorrhagic with rapid progression from initial symptoms to death. Some cases have occurred shortly after initial use as well as after several years of use. The rate based upon the reported cases exceeds that expected in the general population and there have been cases in which pancreatitis recurred after rechallenge with valproate. In clinical trials, there were 2 cases of pancreatitis without alternative etiology in 2416 patients, representing 1044 patient-years experience. Patients and guardians should be warned that abdominal pain, nausea, vomiting, and/or anorexia can be symptoms of pancreatitis that require prompt medical evaluation.

If pancreatitis is diagnosed, valproate should ordinarily be discontinued. Alternative treatment for the underlying medical condition should be initiated as clinically indicated (see **BOX WARNING**).

### **Urea Cycle Disorders (UCD)**

Valproate sodium is contraindicated in patients with known urea cycle disorders.

Hyperammonemic encephalopathy, sometimes fatal, has been reported following initiation of valproate therapy in patients with urea cycle disorders, a group of uncommon genetic abnormalities, particularly ornithine transcarbamylase deficiency. Prior to the initiation of valproate therapy, evaluation for UCD should be considered in the following patients: 1) those with a history of unexplained encephalopathy or coma, encephalopathy associated with a protein load, pregnancy-related or postpartum encephalopathy, unexplained mental retardation, or history of elevated plasma ammonia or glutamine; 2) those with cyclical vomiting and lethargy, episodic extreme irritability, ataxia, low BUN, or protein avoidance; 3) those with a family history of UCD or a family history of unexplained infant deaths (particularly males); 4) those with other signs or symptoms of UCD. Patients who develop symptoms of unexplained hyperammonemic encephalopathy while receiving valproate therapy should receive prompt treatment (including discontinuation of valproate therapy) and be evaluated for underlying urea cycle disorders (see **CONTRAINDICATIONS** and **PRECAUTIONS**).

### **Somnolence in the Elderly**

In a double-blind, multicenter trial of valproate in elderly patients with dementia (mean age = 83 years), doses were increased by 125 mg/day to a target dose of 20 mg/kg/day. A significantly higher proportion of valproate patients had somnolence compared to placebo, and although not statistically significant, there was a higher proportion of patients with dehydration. Discontinuations for somnolence were also significantly higher than with placebo. In some patients with somnolence (approximately one-half), there was associated reduced nutritional intake and weight loss. There was a trend for the patients who experienced these events to have a lower baseline albumin concentration, lower valproate clearance, and a higher BUN. In elderly patients, dosage should be increased more slowly and with regular monitoring for fluid and nutritional intake, dehydration, somnolence, and other adverse events.

Dose reductions or discontinuation of valproate should be considered in patients with decreased food or fluid intake and in patients with excessive somnolence (see **DOSAGE AND ADMINISTRATION**).

### **Thrombocytopenia**

The frequency of adverse effects (particularly elevated liver enzymes and thrombocytopenia [see **PRECAUTIONS**]) may be dose-related. In a clinical trial of divalproex sodium as monotherapy in patients with epilepsy, 34/126 patients (27%) receiving approximately 50 mg/kg/day on average, had at least one value of platelets  $\leq 75 \times 10^9/L$ . Approximately half of these patients had treatment discontinued, with return of platelet counts to normal. In the remaining patients, platelet counts normalized with continued treatment. In this study, the probability of thrombocytopenia appeared to increase significantly at total valproate concentrations of  $>110$  mcg/mL (females) or  $>135$  mcg/mL (males). The therapeutic benefit which may accompany the higher doses should therefore be weighed against the possibility of a greater incidence of adverse effects.

### **Post-traumatic Seizures**

A study was conducted to evaluate the effect of IV valproate in the prevention of post-traumatic seizures in patients with acute head injuries. Patients were randomly assigned to receive either IV valproate given for one week (followed by oral valproate products for either one or six months per random treatment assignment) or IV phenytoin given for one week (followed by placebo). In this study, the incidence of death was found to be higher in the two groups assigned to valproate treatment compared to the rate in those assigned to the IV phenytoin treatment group (13% vs 8.5%, respectively). Many of these patients were critically ill with multiple and/or severe injuries, and evaluation of the causes of death did not suggest any specific drug-related causation. Further, in the absence of a concurrent placebo control during the initial week of intravenous therapy, it is impossible to determine if the mortality rate in the patients treated with valproate was greater or less than that expected in a similar group not treated with valproate, or whether the rate seen in the IV phenytoin treated patients was lower than would be expected. Nonetheless, until further information is available, it seems prudent not to use valproate sodium injection in patients with acute head trauma for the prophylaxis of post-traumatic seizures.

### **Usage in Pregnancy**

VALPROATE CAN PRODUCE TERATOGENIC EFFECTS. DATA SUGGEST THAT THERE IS AN INCREASED INCIDENCE OF CONGENITAL MALFORMATIONS ASSOCIATED WITH THE USE OF VALPROATE BY WOMEN WITH SEIZURE DISORDERS DURING PREGNANCY WHEN COMPARED TO THE INCIDENCE IN WOMEN WITH SEIZURE DISORDERS WHO DO NOT USE ANTIEPILEPTIC DRUGS DURING PREGNANCY, THE INCIDENCE IN WOMEN WITH SEIZURE DISORDERS WHO USE OTHER ANTIEPILEPTIC DRUGS, AND THE BACKGROUND INCIDENCE FOR THE GENERAL POPULATION. THEREFORE, VALPROATE SHOULD BE CONSIDERED FOR WOMEN OF CHILDBEARING POTENTIAL ONLY AFTER THE RISKS HAVE BEEN THOROUGHLY DISCUSSED WITH THE PATIENT AND WEIGHED AGAINST THE POTENTIAL BENEFITS OF TREATMENT.

THERE ARE MULTIPLE REPORTS IN THE CLINICAL LITERATURE THAT INDICATE THE USE OF ANTIEPILEPTIC DRUGS DURING PREGNANCY RESULTS IN AN INCREASED INCIDENCE OF CONGENITAL MALFORMATIONS IN OFFSPRING. ANTIEPILEPTIC DRUGS, INCLUDING VALPROATE, SHOULD BE ADMINISTERED TO WOMEN OF

CHILDBEARING POTENTIAL ONLY IF THEY ARE CLEARLY SHOWN TO BE ESSENTIAL IN THE MANAGEMENT OF THEIR MEDICAL CONDITION.

Antiepileptic drugs should not be discontinued abruptly in patients in whom the drug is administered to prevent major seizures because of the strong possibility of precipitating status epilepticus with attendant hypoxia and threat to life. In individual cases where the severity and frequency of the seizure disorder are such that the removal of medication does not pose a serious threat to the patient, discontinuation of the drug may be considered prior to and during pregnancy, although it cannot be said with any confidence that even minor seizures do not pose some hazard to the developing embryo or fetus.

## HUMAN DATA

### Congenital Malformations

The North American Antiepileptic Drug Pregnancy Registry reported 16 cases of congenital malformations among the offspring of 149 women with epilepsy who were exposed to valproic acid monotherapy during the first trimester of pregnancy at doses of approximately 1,000 mg per day, for a prevalence rate of 10.7% (95% CI 6.3% to 16.9%). Three of the 149 offspring (2%) had neural tube defects and 6 of the 149 (4%) had less severe malformations. Among epileptic women who were exposed to other antiepileptic drug monotherapies during pregnancy (1,048 patients) the malformation rate was 2.9% (95% CI 2% to 4.1%). There was a 4-fold increase in congenital malformations among infants with valproic acid-exposed mothers compared with those treated with other antiepileptic monotherapies as a group (Odds Ratio 4; 95% CI 2.1 to 7.4). This increased risk does not reflect a comparison versus any specific antiepileptic drug, but the risk versus the heterogeneous group of all other antiepileptic drug monotherapies combined. The increased teratogenic risk from valproic acid in women with epilepsy is expected to be reflected in an increased risk in other indications (e.g., migraine or bipolar disorder).

THE STRONGEST ASSOCIATION OF MATERNAL VALPROATE USAGE WITH CONGENITAL MALFORMATIONS IS WITH NEURAL TUBE DEFECTS (AS DISCUSSED UNDER THE NEXT SUBHEADING). HOWEVER, OTHER CONGENITAL ANOMALIES (E.G., CRANIOFACIAL DEFECTS, CARDIOVASCULAR MALFORMATIONS AND ANOMALIES INVOLVING VARIOUS BODY SYSTEMS), COMPATIBLE AND INCOMPATIBLE WITH LIFE, HAVE BEEN REPORTED. SUFFICIENT DATA TO DETERMINE THE INCIDENCE OF THESE CONGENITAL ANOMALIES IS NOT AVAILABLE.

### Neural Tube Defects

THE INCIDENCE OF NEURAL TUBE DEFECTS IN THE FETUS IS INCREASED IN MOTHERS RECEIVING VALPROATE DURING THE FIRST TRIMESTER OF PREGNANCY. THE CENTERS FOR DISEASE CONTROL (CDC) HAS ESTIMATED THE RISK OF VALPROIC ACID EXPOSED WOMEN HAVING CHILDREN WITH SPINA BIFIDA TO BE APPROXIMATELY 1 TO 2%. THE AMERICAN COLLEGE OF OBSTETRICIANS AND GYNECOLOGISTS (ACOG) ESTIMATES THE GENERAL POPULATION RISK FOR CONGENITAL NEURAL TUBE DEFECTS AS 0.14% TO 0.2%.

Tests to detect neural tube and other defects using current accepted procedures should be considered a part of routine prenatal care in pregnant women receiving valproate.

Evidence suggests that pregnant women who receive folic acid supplementation may be at decreased risk for congenital neural tube defects in their offspring compared to pregnant women not receiving folic acid. Whether the risk of neural tube defects in the offspring of women receiving valproate specifically is reduced by folic acid supplementation is unknown.

DIETARY FOLIC ACID SUPPLEMENTATION BOTH PRIOR TO AND DURING PREGNANCY SHOULD BE ROUTINELY RECOMMENDED TO PATIENTS CONTEMPLATING PREGNANCY.

### Other Adverse Pregnancy Effects

PATIENTS TAKING VALPROATE MAY DEVELOP CLOTTING ABNORMALITIES (SEE **PRECAUTIONS, General AND WARNINGS**). A PATIENT WHO HAD LOW FIBRINOGEN WHEN TAKING MULTIPLE ANTICONVULSANTS INCLUDING VALPROATE GAVE BIRTH TO AN INFANT WITH AFIBRINOGENEMIA WHO SUBSEQUENTLY DIED OF HEMORRHAGE. IF VALPROATE IS USED IN PREGNANCY, THE CLOTTING PARAMETERS SHOULD BE MONITORED CAREFULLY.

PATIENTS TAKING VALPROATE MAY DEVELOP HEPATIC FAILURE (SEE **WARNINGS, Hepatotoxicity AND BOX WARNING**). FATAL HEPATIC FAILURES, IN A NEWBORN AND IN AN INFANT, HAVE BEEN REPORTED FOLLOWING THE MATERNAL USE OF VALPROATE DURING PREGNANCY.

## ANIMAL DATA

Animal studies have demonstrated valproate-induced teratogenicity. Increased frequencies of malformations, as well as intrauterine growth retardation and death, have been observed in mice, rats, rabbits, and monkeys following prenatal exposure to valproate. Malformations of the skeletal system are the most common structural abnormalities produced in experimental animals, but neural tube closure defects have been seen in mice exposed to maternal plasma valproate concentrations exceeding 230 mcg/mL (2.3 times the

upper limit of the human therapeutic range) during susceptible periods of embryonic development. Administration of an oral dose of 200 mg/kg/day or greater (50% of the maximum human daily dose or greater on a mg/m<sup>2</sup> basis) to pregnant rats during organogenesis produced malformations (skeletal, cardiac, and urogenital) and growth retardation in the offspring. These doses resulted in peak maternal plasma valproate levels of approximately 340 mcg/mL or greater (3.4 times the upper limit of the human therapeutic range or greater). Behavioral deficits have been reported in the offspring of rats given a dose of 200 mg/kg/day throughout most of pregnancy.

An oral dose of 350 mg/kg/day (approximately 2 times the maximum human daily dose on a mg/m<sup>2</sup> basis) produced skeletal and visceral malformations in rabbits exposed during organogenesis. Skeletal malformations, growth retardation, and death were observed in rhesus monkeys following administration of an oral dose of 200 mg/kg/day (equal to the maximum human daily dose on a mg/m<sup>2</sup> basis) during organogenesis. This dose resulted in peak maternal plasma valproate levels of approximately 280 mcg/mL (2.8 times the upper limit of the human therapeutic range).

## **PRECAUTIONS**

### **Hepatic Dysfunction**

See **BOX WARNING, CONTRAINDICATIONS** and **WARNINGS**.

### **Pancreatitis**

See **BOX WARNING** and **WARNINGS**.

### **Hyperammonemia**

Hyperammonemia has been reported in association with valproate therapy and may be present despite normal liver function tests. In patients who develop unexplained lethargy and vomiting or changes in mental status, hyperammonemic encephalopathy should be considered and an ammonia level should be measured. If ammonia is increased, valproate therapy should be discontinued. Appropriate interventions for treatment of hyperammonemia should be initiated, and such patients should undergo investigation for underlying urea cycle disorders (see **CONTRAINDICATIONS** and **WARNINGS, Urea Cycle Disorders (UCD)** and **PRECAUTIONS, Hyperammonemia and Encephalopathy Associated with Concomitant Topiramate Use**).

Asymptomatic elevations of ammonia are more common and when present, require close monitoring of plasma ammonia levels. If the elevation persists, discontinuation of valproate therapy should be considered.

### **Hyperammonemia and Encephalopathy Associated with Concomitant Topiramate Use**

Concomitant administration of topiramate and valproic acid has been associated with hyperammonemia with or without encephalopathy in patients who have tolerated either drug alone. Clinical symptoms of hyperammonemic encephalopathy often include acute alterations in level of consciousness and/or cognitive function with lethargy or vomiting. In most cases, symptoms and signs abated with discontinuation of either drug. This adverse event is not due to a pharmacokinetic interaction. It is not known if topiramate monotherapy is associated with hyperammonemia. Patients with inborn errors of metabolism or reduced hepatic mitochondrial activity may be at an increased risk for hyperammonemia with or without encephalopathy. Although not studied, an interaction of topiramate and valproic acid may exacerbate existing defects or unmask deficiencies in susceptible persons. In patients who develop unexplained lethargy, vomiting, or changes in mental status, hyperammonemic encephalopathy should be considered and an ammonia level should be measured. (See **CONTRAINDICATIONS** and **WARNINGS, Urea Cycle Disorders (UCD)** and **PRECAUTIONS, Hyperammonemia**).

### **General**

Because of reports of thrombocytopenia (see **WARNINGS**), inhibition of the secondary phase of platelet aggregation, and abnormal coagulation parameters, (e.g., low fibrinogen), platelet counts and coagulation tests are recommended before initiating therapy and at periodic intervals. It is recommended that patients receiving valproate sodium injection be monitored for platelet count and coagulation parameters prior to planned surgery. In a clinical trial of divalproex sodium as monotherapy in patients with epilepsy, 34/126 patients (27%) receiving approximately 50 mg/kg/day on average, had at least one value of platelets  $\leq 75 \times 10^9$ /L. Approximately half of these patients had treatment discontinued, with return of platelet counts to normal. In the remaining patients, platelet counts normalized with continued treatment. In this study, the probability of thrombocytopenia appeared to increase significantly at total valproate concentrations of  $\geq 110$  mcg/mL (females) or  $\geq 135$  mcg/mL (males). Evidence of hemorrhage, bruising, or a disorder of hemostasis/coagulation is an indication for reduction of the dosage or withdrawal of therapy.

Since valproate sodium injection may interact with concurrently administered drugs which are capable of enzyme induction, periodic plasma concentration determinations of valproate and concomitant drugs are recommended during the early course of therapy. (See **PRECAUTIONS, Drug interactions**.)

Valproate is partially eliminated in the urine as a keto-metabolite which may lead to a false interpretation of the urine ketone test. There have been reports of altered thyroid function tests associated with valproate. The clinical significance of these is unknown. There are *in vitro* studies that suggest valproate stimulates the replication of the HIV and CMV viruses under certain experimental conditions. The clinical consequence, if any, is not known. Additionally, the relevance of these *in vitro* findings is uncertain for patients receiving maximally suppressive antiretroviral therapy. Nevertheless, these data should be borne in mind when interpreting



the results from regular monitoring of the viral load in HIV infected patients receiving valproate or when following CMV infected patients clinically.

### Multi-organ Hypersensitivity Reaction

Multi-organ hypersensitivity reactions have been rarely reported in close temporal association to the initiation of valproate therapy in adult and pediatric patients (median time to detection 21 days; range 1 to 40 days). Although there have been a limited number of reports, many of these cases resulted in hospitalization and at least one death has been reported. Signs and symptoms of this disorder were diverse; however, patients typically, although not exclusively, presented with fever and rash associated with other organ system involvement. Other associated manifestations may include lymphadenopathy, hepatitis, liver function test abnormalities, hematological abnormalities (e.g., eosinophilia, thrombocytopenia, neutropenia), pruritis, nephritis, oliguria, hepato-renal syndrome, arthralgia, and asthenia. Because the disorder is variable in its expression, other organ system symptoms and signs, not noted here, may occur. If this reaction is suspected, valproate should be discontinued and an alternative treatment started. Although the existence of cross sensitivity with other drugs that produce this syndrome is unclear, the experience amongst drugs associated with multi-organ hypersensitivity would indicate this to be a possibility.

### Information for patients

Patients and guardians should be warned that abdominal pain, nausea, vomiting, and/or anorexia can be symptoms of pancreatitis and, therefore, require further medical evaluation promptly.

Patients should be informed of the signs and symptoms associated with hyperammonemic encephalopathy (see **PRECAUTIONS, Hyperammonemia**) and be told to inform the prescriber if any of these symptoms occur.

Since valproate sodium injection may produce CNS depression, especially when combined with another CNS depressant (e.g., alcohol), patients should be advised not to engage in hazardous activities, such as driving an automobile or operating dangerous machinery, until it is known that they do not become drowsy from the drug.

Since divalproex sodium has been associated with certain types of birth defects, female patients of childbearing age considering the use of valproate sodium injection should be advised of the risk and of alternative therapeutic options and to read the Patient Information Leaflet, which appears as the last section of the labeling. **This is especially important when the treatment of a spontaneously reversible condition not ordinarily associated with permanent injury or risk of death (e.g., migraine) is considered.**

Patients should be instructed that a fever associated with other organ system involvement (rash, lymphadenopathy, etc.) may be drug-related and should be reported to the physician immediately (see **PRECAUTIONS, Multi-organ Hypersensitivity Reaction**).

### Interactions

#### Drug interactions

#### Effects of Co-Administered Drugs on Valproate Clearance

Drugs that affect the level of expression of hepatic enzymes, particularly those that elevate levels of glucuronosyltransferases, may increase the clearance of valproate. For example, phenytoin, carbamazepine, and phenobarbital (or primidone) can double the clearance of valproate. Thus, patients on monotherapy will generally have longer half-lives and higher concentrations than patients receiving polytherapy with antiepilepsy drugs.

In contrast, drugs that are inhibitors of cytochrome P450 isozymes, e.g., antidepressants, may be expected to have little effect on valproate clearance because cytochrome P450 microsomal mediated oxidation is a relatively minor secondary metabolic pathway compared to glucuronidation and beta-oxidation.

Because of these changes in valproate clearance, monitoring of valproate and concomitant drug concentrations should be increased whenever enzyme inducing drugs are introduced or withdrawn.

The following list provides information about the potential for an influence of several commonly prescribed medications on valproate pharmacokinetics. The list is not exhaustive nor could it be, since new interactions are continuously being reported.

#### Drugs for Which a Potentially Important Interaction Has Been Observed:

**Aspirin** — A study involving the co-administration of aspirin at antipyretic doses (11 to 16 mg/kg) with valproate to pediatric patients (n=6) revealed a decrease in protein binding and an inhibition of metabolism of valproate. Valproate free fraction was increased 4-fold in the presence of aspirin compared to valproate alone. The  $\beta$ -oxidation pathway consisting of 2-E-valproic acid, 3-OH-valproic acid, and 3-keto valproic acid was decreased from 25% of total metabolites excreted on valproate alone to 8.3% in the presence of aspirin. Caution should be observed if valproate and aspirin are to be co-administered.

**Felbamate** — A study involving the co-administration of 1200 mg/day of felbamate with valproate to patients with epilepsy (n=10) revealed an increase in mean valproate peak concentration by 35% (from 86 to 115 mcg/mL) compared to valproate alone. Increasing

the felbamate dose to 2400 mg/day increased the mean valproate peak concentration to 133 mcg/mL (another 16% increase). A decrease in valproate dosage may be necessary when felbamate therapy is initiated.

**Meropenem** — Subtherapeutic valproic acid levels have been reported when meropenem was co-administered.

**Rifampin** — A study involving the administration of a single dose of valproate (7 mg/kg) 36 hours after 5 nights of daily dosing with rifampin (600 mg) revealed a 40% increase in the oral clearance of valproate. Valproate dosage adjustment may be necessary when it is co-administered with rifampin.

**Drugs for Which Either No Interaction or a Likely Clinically Unimportant Interaction Has Been Observed:**

**Antacids** — A study involving the co-administration of valproate 500 mg with commonly administered antacids (Maalox, Trisogel, and Titralac - 160 mEq doses) did not reveal any effect on the extent of absorption of valproate.

**Chlorpromazine** — A study involving the administration of 100 to 300 mg/day of chlorpromazine to schizophrenic patients already receiving valproate (200 mg BID) revealed a 15% increase in trough plasma levels of valproate.

**Haloperidol** — A study involving the administration of 6 to 10 mg/day of haloperidol to schizophrenic patients already receiving valproate (200 mg BID) revealed no significant changes in valproate trough plasma levels.

**Cimetidine and Ranitidine** — Cimetidine and ranitidine do not affect the clearance of valproate.

**Effects of Valproate on Other Drugs**

Valproate has been found to be a weak inhibitor of some P450 isozymes, epoxide hydrase, and glucuronyl transferases.

The following list provides information about the potential for an influence of valproate co-administration on the pharmacokinetics or pharmacodynamics of several commonly prescribed medications. The list is not exhaustive, since new interactions are continuously being reported.

**Drugs for Which a Potentially Important Valproate Interaction Has Been Observed:**

**Amitriptyline/Nortriptyline** — Administration of a single oral 50 mg dose of amitriptyline to 15 normal volunteers (10 males and 5 females) who received valproate (500 mg BID) resulted in a 21% decrease in plasma clearance of amitriptyline and a 34% decrease in the net clearance of nortriptyline. Rare postmarketing reports of concurrent use of valproate and amitriptyline resulting in an increased amitriptyline level have been received. Concurrent use of valproate and amitriptyline has rarely been associated with toxicity. Monitoring of amitriptyline levels should be considered for patients taking valproate concomitantly with amitriptyline. Consideration should be given to lowering the dose of amitriptyline/nortriptyline in the presence of valproate.

**Carbamazepine/Carbamazepine-10,11-Epoxy** — Serum levels of carbamazepine (CBZ) decreased 17% while that of carbamazepine-10,11-epoxide (CBZ-E) increased by 45% upon co-administration of valproate and CBZ to epileptic patients.

**Clonazepam** — The concomitant use of valproic acid and clonazepam may induce absence status in patients with a history of absence type seizures.

**Diazepam** — Valproate displaces diazepam from its plasma albumin binding sites and inhibits its metabolism. Co-administration of valproate (1500 mg daily) increased the free fraction of diazepam (10 mg) by 90% in healthy volunteers (n=6). Plasma clearance and volume of distribution for free diazepam were reduced by 25% and 20%, respectively, in the presence of valproate. The elimination half-life of diazepam remained unchanged upon addition of valproate.

**Ethosuximide** — Valproate inhibits the metabolism of ethosuximide. Administration of a single ethosuximide dose of 500 mg with valproate (800 to 1600 mg/day) to healthy volunteers (n=6) was accompanied by a 25% increase in elimination half-life of ethosuximide and a 15% decrease in its total clearance as compared to ethosuximide alone. Patients receiving valproate and ethosuximide, especially along with other anticonvulsants, should be monitored for alterations in serum concentrations of both drugs.

**Lamotrigine** — In a steady-state study involving 10 healthy volunteers, the elimination half-life of lamotrigine increased from 26 to 70 hours with valproate co-administration (a 165% increase). The dose of lamotrigine should be reduced when co-administered with valproate. Serious skin reactions (such as Stevens-Johnson Syndrome and toxic epidermal necrolysis) have been reported with concomitant lamotrigine and valproate administration. See lamotrigine package insert for details on lamotrigine dosing with concomitant valproate administration.

**Phenobarbital** — Valproate was found to inhibit the metabolism of phenobarbital. Co-administration of valproate (250 mg BID for 14 days) with phenobarbital to normal subjects (n=6) resulted in a 50% increase in half-life and a 30% decrease in plasma clearance of phenobarbital (60 mg single-dose). The fraction of phenobarbital dose excreted unchanged increased by 50% in presence of valproate.

There is evidence for severe CNS depression, with or without significant elevations of barbiturate or valproate serum concentrations. All patients receiving concomitant barbiturate therapy should be closely monitored for neurological toxicity. Serum barbiturate concentrations should be obtained, if possible, and the barbiturate dosage decreased, if appropriate.

Primidone, which is metabolized to a barbiturate, may be involved in a similar interaction with valproate.

Phenytoin — Valproate displaces phenytoin from its plasma albumin binding sites and inhibits its hepatic metabolism. Co-administration of valproate (400 mg TID) with phenytoin (250 mg) in normal volunteers (n=7) was associated with a 60% increase in the free fraction of phenytoin. Total plasma clearance and apparent volume of distribution of phenytoin increased 30% in the presence of valproate. Both the clearance and apparent volume of distribution of free phenytoin were reduced by 25%.

In patients with epilepsy, there have been reports of breakthrough seizures occurring with the combination of valproate and phenytoin. The dosage of phenytoin should be adjusted as required by the clinical situation.

Tolbutamide — From *in vitro* experiments, the unbound fraction of tolbutamide was increased from 20% to 50% when added to plasma samples taken from patients treated with valproate. The clinical relevance of this displacement is unknown.

Topiramate — Concomitant administration of valproic acid and topiramate has been associated with hyperammonemia with and without encephalopathy (see **CONTRAINDICATIONS** and **WARNINGS, Urea Cycle Disorders (UCD)** and **PRECAUTIONS, Hyperammonemia** and **Hyperammonemia and Encephalopathy Associated with Concomitant Topiramate Use**).

Warfarin — In an *in vitro* study, valproate increased the unbound fraction of warfarin by up to 32.6%. The therapeutic relevance of this is unknown; however, coagulation tests should be monitored if valproate therapy is instituted in patients taking anticoagulants.

Zidovudine — In six patients who were seropositive for HIV, the clearance of zidovudine (100 mg q8h) was decreased by 38% after administration of valproate (250 or 500 mg q8h); the half-life of zidovudine was unaffected.

Drugs for Which Either No Interaction or a Likely Clinically Unimportant Interaction Has Been Observed:

Acetaminophen — Valproate had no effect on any of the pharmacokinetic parameters of acetaminophen when it was concurrently administered to three epileptic patients.

Clozapine — In psychotic patients (n=11), no interaction was observed when valproate was coadministered with clozapine.

Lithium — Co-administration of valproate (500 mg BID) and lithium carbonate (300 mg TID) to normal male volunteers (n=16) had no effect on the steady-state kinetics of lithium.

Lorazepam — Concomitant administration of valproate (500 mg BID) and lorazepam (1 mg BID) in normal male volunteers (n=9) was accompanied by a 17% decrease in the plasma clearance of lorazepam.

Oral Contraceptive Steroids — Administration of a single-dose of ethinyloestradiol (50 mcg)/levonorgestrel (250 mcg) to 6 women on valproate (200 mg BID) therapy for 2 months did not reveal any pharmacokinetic interaction.

### **Carcinogenesis, mutagenesis, impairment of fertility**

#### **Carcinogenesis**

Valproic acid was administered orally to Sprague Dawley rats and ICR (HA/ICR) mice at doses of 80 and 170 mg/kg/day (approximately 10 to 50% of the maximum human daily dose on a mg/m<sup>2</sup> basis) for two years. A variety of neoplasms were observed in both species. The chief findings were a statistically significant increase in the incidence of subcutaneous fibrosarcomas in high dose male rats receiving valproic acid and a statistically significant dose-related trend for benign pulmonary adenomas in male mice receiving valproic acid. The significance of these findings for humans is unknown.

#### **Mutagenesis**

Valproate was not mutagenic in an *in vitro* bacterial assay (Ames test), did not produce dominant lethal effects in mice, and did not increase chromosome aberration frequency in an *in vivo* cytogenetic study in rats. Increased frequencies of sister chromatid exchange (SCE) have been reported in a study of epileptic children taking valproate, but this association was not observed in another study conducted in adults. There is some evidence that increased SCE frequencies may be associated with epilepsy. The biological significance of an increase in SCE frequency is not known.

#### **Fertility**

Chronic toxicity studies in juvenile and adult rats and dogs demonstrated reduced spermatogenesis and testicular atrophy at oral doses of 400 mg/kg/day or greater in rats (approximately equivalent to or greater than the maximum human daily dose on a mg/m<sup>2</sup> basis)

and 150 mg/kg/day or greater in dogs (approximately 1.4 times the maximum human daily dose or greater on a mg/m<sup>2</sup> basis). Segment I fertility studies in rats have shown oral doses up to 350 mg/kg/day (approximately equal to the maximum human daily dose on a mg/m<sup>2</sup> basis) for 60 days to have no effect on fertility. THE EFFECT OF VALPROATE ON TESTICULAR DEVELOPMENT AND ON SPERM PRODUCTION AND FERTILITY IN HUMANS IS UNKNOWN.

## Pregnancy

Teratogenic effects

Pregnancy Category D

See **WARNINGS**.

## Nursing mothers

Valproate is excreted in breast milk. Concentrations in breast milk have been reported to be 1 to 10% of serum concentrations. It is not known what effect this would have on a nursing infant. Consideration should be given to discontinuing nursing when valproate is administered to a nursing woman.

## Pediatric use

Experience with oral valproate has indicated that pediatric patients under the age of two years are at a considerably increased risk of developing fatal hepatotoxicity, especially those with the aforementioned conditions (see **BOX WARNING**). The safety of valproate sodium injection has not been studied in individuals below the age of 2 years. If a decision is made to use valproate sodium injection in this age group, it should be used with extreme caution and as a sole agent. The benefits of therapy should be weighed against the risks. Above the age of 2 years, experience in epilepsy has indicated that the incidence of fatal hepatotoxicity decreases considerably in progressively older patient groups.

Younger children, especially those receiving enzyme-inducing drugs, will require larger maintenance doses to attain targeted total and unbound valproic acid concentrations.

The variability in free fraction limits the clinical usefulness of monitoring total serum valproic acid concentrations. Interpretation of valproic acid concentrations in children should include consideration of factors that affect hepatic metabolism and protein binding. No unique safety concerns were identified in the 35 patients age 2 to 17 years who received valproate sodium injection in clinical trials.

The basic toxicology and pathologic manifestations of valproate sodium in neonatal (4-day old) and juvenile (14-day old) rats are similar to those seen in young adult rats. However, additional findings, including renal alterations in juvenile rats and renal alterations and retinal dysplasia in neonatal rats, have been reported. These findings occurred at 240 mg/kg/day, a dosage approximately equivalent to the human maximum recommended daily dose on a mg/m<sup>2</sup> basis. They were not seen at 90 mg/kg, or 40% of the maximum human daily dose on a mg/m<sup>2</sup> basis.

## Geriatric use

No patients above the age of 65 years were enrolled in double-blind prospective clinical trials of mania associated with bipolar illness. In a case review study of 583 patients, 72 patients (12%) were greater than 65 years of age. A higher percentage of patients above 65 years of age reported accidental injury, infection, pain, somnolence, and tremor. Discontinuation of valproate was occasionally associated with the latter two events. It is not clear whether these events indicate additional risk or whether they result from preexisting medical illness and concomitant medication use among these patients.

A study of elderly patients with dementia revealed drug related somnolence and discontinuation for somnolence (see **WARNINGS, Somnolence in the Elderly**). The starting dose should be reduced in these patients, and dosage reductions or discontinuation should be considered in patients with excessive somnolence (see **DOSAGE AND ADMINISTRATION**).

No unique safety concerns were identified in the 21 patients >65 years of age receiving valproate sodium injection in clinical trials.

## ADVERSE REACTIONS

The adverse events that can result from valproate sodium injection use include all of those associated with oral forms of valproate. The following describes experience specifically with valproate sodium injection. Valproate sodium injection has been generally well tolerated in clinical trials involving 111 healthy adult male volunteers and 352 patients with epilepsy, given at doses of 125 to 6000 mg (total daily dose). A total of 2% of patients discontinued treatment with valproate sodium injection due to adverse events. The most common adverse events leading to discontinuation were 2 cases each of nausea/vomiting and elevated amylase. Other adverse events leading to discontinuation were hallucinations, pneumonia, headache, injection site reaction, and abnormal gait. Dizziness and injection site pain were observed more frequently at a 100 mg/min infusion rate than at rates up to 33 mg/min. At a 200 mg/min rate, dizziness and taste perversion occurred more frequently than at a 100 mg/min rate. The maximum rate of infusion studied was 200 mg/min.

Adverse events reported by at least 0.5% of all subjects/patients in clinical trials of valproate sodium injection are summarized in Table 1.

Table 1. Adverse Events Reported During Studies of Valproate Sodium Injection

Body System/Event	n = 463	Body System/Event	n = 463
<b>Body as a Whole</b>		<b>Nervous System</b>	
Chest Pain	1.7%	Dizziness	5.2%
Headache	4.3%	Euphoria	0.9%
Injection Site Inflammation	0.6%	Hypesthesia	0.6%
Injection Site Pain	2.6%	Nervousness	0.9%
Injection Site Reaction	2.4%	Paresthesia	0.9%
Pain (unspecified)	1.3%	Somnolence	1.7%
<b>Cardiovascular</b>		Tremor	0.6%
Vasodilation	0.9%	<b>Respiratory</b>	
<b>Dermatologic</b>		Pharyngitis	0.6%
Sweating	0.9%	<b>Special Senses</b>	
<b>Digestive System</b>		Taste Perversion	1.9%
Abdominal Pain	1.1%		
Diarrhea	0.9%		
Nausea	3.2%		
Vomiting	1.3%		

In a separate clinical safety trial, 112 patients with epilepsy were given infusions of valproate injection (up to 15 mg/kg) over 5 to 10 minutes (1.5 to 3 mg/kg/min). The common adverse events (> 2%) were somnolence (10.7%), dizziness (7.1%), paresthesia (7.1%), asthenia (7.1%), nausea (6.3%), and headache (2.7%). While the incidence of these adverse events was generally higher than in Table 1 (experience encompassing the standard, much slower infusion rates), e.g., somnolence (1.7%), dizziness (5.2%), paresthesia (0.9%), asthenia (0%), nausea (3.2%), and headache (4.3%), a direct comparison between the incidence of adverse events in the 2 cohorts cannot be made because of differences in patient populations and study designs.

Ammonia levels have not been systematically studied after IV valproate, so that an estimate of the incidence of hyperammonemia after IV valproate cannot be provided. Hyperammonemia with encephalopathy has been reported in 2 patients after infusions of valproate injection.

### Epilepsy

Based on a placebo-controlled trial of adjunctive therapy for treatment of complex partial seizures, divalproex sodium was generally well tolerated with most adverse events rated as mild to moderate in severity. Intolerance was the primary reason for discontinuation in the divalproex sodium-treated patients (6%), compared to 1% of placebo-treated patients.

Table 2 lists treatment-emergent adverse events which were reported by ≥5% of divalproex sodium-treated patients and for which the incidence was greater than in the placebo group, in the placebo-controlled trial of adjunctive therapy for treatment of complex partial seizures. Since patients were also treated with other antiepilepsy drugs, it is not possible, in most cases, to determine whether the following adverse events can be ascribed to divalproex sodium alone, or the combination of divalproex sodium and other antiepilepsy drugs.

Table 2. Adverse Events Reported by ≥5 % of Patients Treated with Divalproex Sodium During Placebo-Controlled Trial of Adjunctive Therapy for Complex Partial Seizures

Body System/Event	Divalproex Sodium (%) (n=77)	Placebo (%) (n=70)
<b>Body as a Whole</b>		
Headache	31	21
Asthenia	27	7
Fever	6	4
<b>Gastrointestinal System</b>		
Nausea	48	14
Vomiting	27	7
Abdominal Pain	23	6
Diarrhea	13	6
Anorexia	12	0

Dyspepsia	8	4
Constipation	5	1
<b>Nervous System</b>		
Somnolence	27	11
Tremor	25	6
Dizziness	25	13
Diplopia	16	9
Amblyopia/Blurred Vision	12	9
Ataxia	8	1
Nystagmus	8	1
Emotional Lability	6	4
Thinking Abnormal	6	0
Amnesia	5	1
<b>Respiratory System</b>		
Flu Syndrome	12	9
Infection	12	6
Bronchitis	5	1
Rhinitis	5	4
<b>Other</b>		
Alopecia	6	1
Weight Loss	6	0

Table 3 lists treatment-emergent adverse events which were reported by  $\geq 5\%$  of patients in the high dose divalproex sodium group, and for which the incidence was greater than in the low dose group, in a controlled trial of divalproex sodium monotherapy treatment of complex partial seizures. Since patients were being titrated off another antiepilepsy drug during the first portion of the trial, it is not possible, in many cases, to determine whether the following adverse events can be ascribed to divalproex sodium alone, or the combination of divalproex sodium and other antiepilepsy drugs.

Table 3. Adverse Events Reported by  $\geq 5\%$  of Patients in the High Dose Group in the Controlled Trial of Divalproex Sodium Monotherapy for Complex Partial Seizures<sup>1</sup>

<b>Body System/Event</b>	<b>High Dose (%) (n=131)</b>	<b>Low Dose (%) (n=134)</b>
<b>Body as a Whole</b>		
Asthenia	21	10
<b>Digestive System</b>		
Nausea	34	26
Diarrhea	23	19
Vomiting	23	15
Abdominal Pain	12	9
Anorexia	11	4
Dyspepsia	11	10
<b>Hemic/Lymphatic System</b>		
Thrombocytopenia	24	1
Ecchymosis	5	4
<b>Metabolic/Nutritional</b>		
Weight Gain	9	4
Peripheral Edema	8	3
<b>Nervous System</b>		

Tremor	57	19
Somnolence	30	18
Dizziness	18	13
Insomnia	15	9
Nervousness	11	7
Amnesia	7	4
Nystagmus	7	1
Depression	5	4
<b>Respiratory System</b>		
Infection	20	13
Pharyngitis	8	2
Dyspnea	5	1
<b>Skin and Appendages</b>		
Alopecia	24	13
<b>Special Senses</b>		
Amblyopia/Blurred Vision	8	4
Tinnitus	7	1

<sup>1</sup>Headache was the only adverse event that occurred in >5% of patients in the high dose group and at an equal or greater incidence in the low dose group.

The following additional adverse events were reported by greater than 1% but less than 5% of the 358 patients treated with divalproex sodium in the controlled trials of complex partial seizures:

Body as a Whole: Back pain, chest pain, malaise.

Cardiovascular System: Tachycardia, hypertension, palpitation.

Digestive System: Increased appetite, flatulence, hematemesis, eructation, pancreatitis, periodontal abscess.

Hemic and Lymphatic System: Petechia.

Metabolic and Nutritional Disorders: SGOT increased, SGPT increased.

Musculoskeletal System: Myalgia, twitching, arthralgia, leg cramps, myasthenia.

Nervous System: Anxiety, confusion, abnormal gait, paresthesia, hypertonia, incoordination, abnormal dreams, personality disorder.

Respiratory System: Sinusitis, cough increased, pneumonia, epistaxis.

Skin and Appendages: Rash, pruritus, dry skin.

Special Senses: Taste perversion, abnormal vision, deafness, otitis media.

Urogenital System: Urinary incontinence, vaginitis, dysmenorrhea, amenorrhea, urinary frequency.

### Other Patient Populations

Adverse events that have been reported with all dosage forms of valproate from epilepsy trials, spontaneous reports, and other sources are listed below by body system.

Gastrointestinal: The most commonly reported side effects at the initiation of therapy are nausea, vomiting, and indigestion. These effects are usually transient and rarely require discontinuation of therapy. Diarrhea, abdominal cramps, and constipation have been reported. Both anorexia with some weight loss and increased appetite with weight gain have also been reported. The administration of delayed-release divalproex sodium may result in reduction of gastrointestinal side effects in some patients using oral therapy.

CNS Effects: Sedative effects have occurred in patients receiving valproate alone but occur most often in patients receiving combination therapy. Sedation usually abates upon reduction of other antiepileptic medication. Tremor (may be dose-related), hallucinations, ataxia, headache, nystagmus, diplopia, asterixis, "spots before eyes", dysarthria, dizziness, confusion, hypesthesia, vertigo, incoordination, and parkinsonism have been reported with the use of valproate. Rare cases of coma have occurred in patients receiving valproate alone or in conjunction with phenobarbital. In rare instances encephalopathy with or without fever has developed shortly after the introduction of valproate monotherapy without evidence of hepatic dysfunction or inappropriately high plasma valproate levels. Although recovery has been described following drug withdrawal, there have been fatalities in patients with hyperammonemic encephalopathy, particularly in patients with underlying urea cycle disorders (see **WARNINGS, Urea Cycle Disorders (UCD)** and **PRECAUTIONS**).

Several reports have noted reversible cerebral atrophy and dementia in association with valproate therapy.

Dermatologic: Transient hair loss, skin rash, photosensitivity, generalized pruritus, erythema multiforme, and Stevens-Johnson syndrome. Rare cases of toxic epidermal necrolysis have been reported including a fatal case in a 6 month old infant taking valproate and several other concomitant medications. An additional case of toxic epidermal necrosis resulting in death was reported in a 35

year old patient with AIDS taking several concomitant medications and with a history of multiple cutaneous drug reactions. Serious skin reactions have been reported with concomitant administration of lamotrigine and valproate (see **PRECAUTIONS, Drug interactions**).

Psychiatric: Emotional upset, depression, psychosis, aggression, hyperactivity, hostility, and behavioral deterioration.

Musculoskeletal: Weakness.

Hematologic: Thrombocytopenia and inhibition of the secondary phase of platelet aggregation may be reflected in altered bleeding time, petechiae, bruising, hematoma formation, epistaxis, and frank hemorrhage (see **PRECAUTIONS, General and Drug interactions**). Relative lymphocytosis, macrocytosis, hypofibrinogenemia, leukopenia, eosinophilia, anemia including macrocytic with or without folate deficiency, bone marrow suppression, pancytopenia, aplastic anemia, agranulocytosis, and acute intermittent porphyria.

Hepatic: Minor elevations of transaminases (e.g., SGOT and SGPT) and LDH are frequent and appear to be dose-related.

Occasionally, laboratory test results include increases in serum bilirubin and abnormal changes in other liver function tests. These results may reflect potentially serious hepatotoxicity (see **WARNINGS**).

Endocrine: Irregular menses, secondary amenorrhea, breast enlargement, galactorrhea, and parotid gland swelling. Abnormal thyroid function tests (see **PRECAUTIONS**).

There have been rare spontaneous reports of polycystic ovary disease. A cause and effect relationship has not been established.

Pancreatic: Acute pancreatitis including fatalities (see **WARNINGS**).

Metabolic: Hyperammonemia (see **PRECAUTIONS**), hyponatremia, and inappropriate ADH secretion.

There have been rare reports of Fanconi's syndrome occurring chiefly in children.

Decreased carnitine concentrations have been reported although the clinical relevance is undetermined.

Hyperglycinemia has occurred and was associated with a fatal outcome in a patient with preexistent nonketotic hyperglycinemia.

Genitourinary: Enuresis and urinary tract infection.

Special Senses: Hearing loss, either reversible or irreversible, has been reported; however, a cause and effect relationship has not been established. Ear pain has also been reported.

Other: Allergic reaction, anaphylaxis, edema of the extremities, lupus erythematosus, bone pain, cough increased, pneumonia, otitis media, bradycardia, cutaneous vasculitis, fever, and hypothermia.

## **Mania**

Although valproate sodium injection has not been evaluated for safety and efficacy in the treatment of manic episodes associated with bipolar disorder, the following adverse events not listed above were reported by 1% or more of patients from two placebo-controlled clinical trials of divalproex sodium tablets.

Body as a Whole: Chills, neck pain, neck rigidity.

Cardiovascular System: Hypotension, postural hypotension, vasodilation.

Digestive System: Fecal incontinence, gastroenteritis, glossitis.

Musculoskeletal System: Arthrosis.

Nervous System: Agitation, catatonic reaction, hypokinesia, reflexes increased, tardive dyskinesia, vertigo.

Skin and Appendages: Furunculosis, maculopapular rash, seborrhea.

Special Senses: Conjunctivitis, dry eyes, eye pain.

Urogenital: Dysuria.

## **Migraine**

Although valproate sodium injection has not been evaluated for safety and efficacy in the prophylactic treatment of migraine headaches, the following adverse events not listed above were reported by 1% or more of patients from two placebo-controlled clinical trials of divalproex sodium tablets.

Body as a Whole: Face edema.

Digestive System: Dry mouth, stomatitis.

Urogenital System: Cystitis, metrorrhagia, and vaginal hemorrhage.

## **OVERDOSAGE**

Overdosage with valproate may result in somnolence, heart block, and deep coma. Fatalities have been reported; however, patients have recovered from valproate serum concentrations as high as 2120 mcg/mL.

In overdose situations, the fraction of drug not bound to protein is high and hemodialysis or tandem hemodialysis plus hemoperfusion may result in significant removal of drug. General supportive measures should be applied with particular attention to the maintenance of adequate urinary output.

Naloxone has been reported to reverse the CNS depressant effects of valproate overdose. Because naloxone could theoretically also reverse the antiepilepsy effects of valproate, it should be used with caution in patients with epilepsy.

## **DOSAGE AND ADMINISTRATION**

VALPROATE SODIUM INJECTION IS FOR INTRAVENOUS USE ONLY.



Use of valproate sodium injection for periods of more than 14 days has not been studied. Patients should be switched to oral valproate products as soon as it is clinically feasible.

Valproate sodium injection should be administered as a 60 minute infusion (but not more than 20 mg/min) with the same frequency as the oral products, although plasma concentration monitoring and dosage adjustments may be necessary.

In one clinical safety study, approximately 90 patients with epilepsy and with no measurable plasma levels of valproate were given single infusions of valproate sodium injection (up to 15 mg/kg and mean dose of 1184 mg) over 5 to 10 minutes (1.5 to 3 mg/kg/min). Patients generally tolerated the more rapid infusions well (see **ADVERSE REACTIONS**). This study was not designed to assess the effectiveness of these regimens. For pharmacokinetics with rapid infusions, see **CLINICAL PHARMACOLOGY**,

#### **Pharmacokinetics - Bioavailability.**

**Initial Exposure to Valproate:** The following dosage recommendations were obtained from studies utilizing oral divalproex sodium products.

**Complex Partial Seizures:** For adults and children 10 years of age or older.

**Monotherapy (Initial Therapy):** Valproate sodium injection has not been systematically studied as initial therapy. Patients should initiate therapy at 10 to 15 mg/kg/day. The dosage should be increased by 5 to 10 mg/kg/week to achieve optimal clinical response. Ordinarily, optimal clinical response is achieved at daily doses below 60 mg/kg/day. If satisfactory clinical response has not been achieved, plasma levels should be measured to determine whether or not they are in the usually accepted therapeutic range (50 to 100 mcg/mL). No recommendation regarding the safety of valproate for use at doses above 60 mg/kg/day can be made.

The probability of thrombocytopenia increases significantly at total trough valproate plasma concentrations above 110 mcg/mL in females and 135 mcg/mL in males. The benefit of improved seizure control with higher doses should be weighed against the possibility of a greater incidence of adverse reactions.

**Conversion to Monotherapy:** Patients should initiate therapy at 10 to 15 mg/kg/day. The dosage should be increased by 5 to 10 mg/kg/week to achieve optimal clinical response. Ordinarily, optimal clinical response is achieved at daily doses below 60 mg/kg/day. If satisfactory clinical response has not been achieved, plasma levels should be measured to determine whether or not they are in the usually accepted therapeutic range (50 to 100 mcg/mL). No recommendation regarding the safety of valproate for use at doses above 60 mg/kg/day can be made. Concomitant antiepilepsy drug (AED) dosage can ordinarily be reduced by approximately 25% every 2 weeks. This reduction may be started at initiation of valproate sodium injection therapy, or delayed by 1 to 2 weeks if there is a concern that seizures are likely to occur with a reduction.

The speed and duration of withdrawal of the concomitant AED can be highly variable, and patients should be monitored closely during this period for increased seizure frequency.

**Adjunctive Therapy:** Valproate sodium injection may be added to the patient's regimen at a dosage of 10 to 15 mg/kg/day. The dosage may be increased by 5 to 10 mg/kg/week to achieve optimal clinical response. Ordinarily, optimal clinical response is achieved at daily doses below 60 mg/kg/day. If satisfactory clinical response has not been achieved, plasma levels should be measured to determine whether or not they are in the usually accepted therapeutic range (50 to 100 mcg/mL). No recommendation regarding the safety of valproate for use at doses above 60 mg/kg/day can be made. If the total daily dose exceeds 250 mg, it should be given in divided doses.

In a study of adjunctive therapy for complex partial seizures in which patients were receiving either carbamazepine or phenytoin in addition to divalproex sodium, no adjustment of carbamazepine or phenytoin dosage was needed (see **CLINICAL STUDIES**). However, since valproate may interact with these or other concurrently administered AEDs as well as other drugs (see **Drug interactions**), periodic plasma concentration determinations of concomitant AEDs are recommended during the early course of therapy (see **PRECAUTIONS, Drug interactions**).

**Simple and Complex Absence Seizures:** The recommended initial dose is 15 mg/kg/day, increasing at one week intervals by 5 to 10 mg/kg/day until seizures are controlled or side effects preclude further increases. The maximum recommended dosage is 60 mg/kg/day. If the total daily dose exceeds 250 mg, it should be given in divided doses.

A good correlation has not been established between daily dose, serum concentrations, and therapeutic effect. However, therapeutic valproate serum concentrations for most patients with absence seizures is considered to range from 50 to 100 mcg/mL. Some patients may be controlled with lower or higher serum concentrations (see **CLINICAL PHARMACOLOGY**).

As the valproate sodium injection dosage is titrated upward, blood concentrations of phenobarbital and/or phenytoin may be affected (see **PRECAUTIONS**).

Antiepilepsy drugs should not be abruptly discontinued in patients in whom the drug is administered to prevent major seizures because of the strong possibility of precipitating status epilepticus with attendant hypoxia and threat to life.

#### **Replacement Therapy:**

When switching from oral valproate products, the total daily dose of valproate sodium injection should be equivalent to the total daily dose of the oral valproate product (see **CLINICAL PHARMACOLOGY**), and should be administered as a 60 minute infusion (but not more than 20 mg/min) with the same frequency as the oral products, although plasma concentration monitoring and dosage adjustments may be necessary. Patients receiving doses near the maximum recommended daily dose of 60 mg/kg/day, particularly those not receiving enzyme-inducing drugs, should be monitored more closely. If the total daily dose exceeds 250 mg, it should be given in a divided regimen. There is no experience with more rapid infusions in patients receiving valproate sodium injection as replacement therapy. However, the equivalence shown between valproate sodium injection and oral valproate products (divalproex sodium) at steady state was only evaluated in an every 6 hour regimen. Whether, when valproate sodium injection is given less frequently (i.e., twice or three times a day), trough levels fall below those that result from an oral dosage form given via the same

regimen, is unknown. For this reason, when valproate sodium injection is given twice or three times a day, close monitoring of trough plasma levels may be needed.

### General Dosing Advice

**Dosing in Elderly Patients** — Due to a decrease in unbound clearance of valproate and possibly a greater sensitivity to somnolence in the elderly, the starting dose should be reduced in these patients. Dosage should be increased more slowly and with regular monitoring for fluid and nutritional intake, dehydration, somnolence, and other adverse events. Dose reductions or discontinuation of valproate should be considered in patients with decreased food or fluid intake and in patients with excessive somnolence. The ultimate therapeutic dose should be achieved on the basis of both tolerability and clinical response (see **WARNINGS**).

**Dose-Related Adverse Events** — The frequency of adverse effects (particularly elevated liver enzymes and thrombocytopenia) may be dose-related. The probability of thrombocytopenia appears to increase significantly at total valproate concentrations of  $\geq 110$  mcg/mL (females) or  $\geq 135$  mcg/mL (males) (see **PRECAUTIONS**). The benefit of improved therapeutic effect with higher doses should be weighed against the possibility of a greater incidence of adverse reactions.

### Administration

Rapid infusion of valproate sodium injection has been associated with an increase in adverse events. There is limited experience with infusion times of less than 60 minutes or rates of infusion  $> 20$  mg/min in patients with epilepsy (see **ADVERSE REACTIONS**).

Valproate sodium injection should be administered intravenously as a 60 minute infusion, as noted above. It should be diluted with at least 50 mL of a compatible diluent. Any unused portion of the vial contents should be discarded.

Parenteral drug products should be inspected visually for particulate matter and discoloration prior to administration whenever solution and container permit.

### Compatibility and Stability

Valproate sodium injection was found to be physically compatible and chemically stable in the following parenteral solutions for at least 24 hours when stored in glass or polyvinyl chloride (PVC) bags at controlled room temperature  $15^{\circ}$  to  $30^{\circ}\text{C}$  ( $59^{\circ}$  to  $86^{\circ}\text{F}$ ).

- dextrose (5%) injection, USP
- sodium chloride (0.9%) injection, USP
- lactated ringer's injection, USP

### HOW SUPPLIED

Valproate Sodium Injection, equivalent to 100 mg of valproic acid per mL, is a clear, colorless solution in 5 mL single-dose vials, available in cartons of 10 vials (**NDC 55390-007-10**).

Recommended storage: Store vials at controlled room temperature  $15^{\circ}$  to  $30^{\circ}\text{C}$  ( $59^{\circ}$  to  $86^{\circ}\text{F}$ ). No preservatives have been added.

Unused portion of container should be discarded.

Manufactured by:

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Bedford, OH 44146

Manufactured for:  
Bedford Laboratories™  
Bedford, OH 44146

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